TWENTY-FIRST CENTURY AGRICULTURE: BESIEGED, PRODUCTIVE, AND PROFITABLE

by
Luther Tweeten

Executive Summary and Conclusions

Economic conditions for twenty-first century agriculture will depend on supply and demand trends. The Uruguay Round of the General Agreement on Tariffs and Trade (GATT) achieved success by including agriculture for the first time, but even if ratified will bring only one-tenth of the potential gains from trade liberalization. Major gains from trade liberalization in the next decade will come from the emerging markets of Asia and from unilateral and regional arrangements. The latter include reforms and extensions of NAFTA, the European Union, and other free trade regions. NAFTA and the Uruguay Round of the GATT together will add about $3 billion to U.S. farm exports in year 2000.

Domestic demand for farm output will advance at a fairly predictable 1 percent per year for the next decade. Adding in export expansion averaging 2.5 to 5.0 percent annually will bring overall domestic and export demand gains to 1.4 to 2.1 percent per annum by year 2000.

The pace of farm technological change will continue strong to year 2000 and beyond, advancing agricultural productivity at a rate just in excess of the 1.4 to 2.1 percent annual rate of increase in demand for farm output. The parity ratio of prices received to prices paid by farmers will continue to fall modestly, but will be more than compensated by increasing productivity so real per capita farm buying power will rise. However, that rise will be obscured by annual and cyclical market variation around the trend.

Most of the productivity gains will come from refinements and extensions in "old" technologies such as artificial insemination, varietal improvement, and expansion in scale (to achieve economies of firm size) rather than from glamorous new technologies such as bovine somatotropin or the information superhighway. An exception is cybernetics combining computerized control of fertilizer and pesticide applications under the Global Positioning System.

Agriculture has made massive progress addressing soil erosion, and remaining environmental problems seem tractable. Soil erosion would be as much as four times greater today without changes in technology and public policies since the 1950s. One concern is that the public and politicians are unaware of the progress induced by the profit motive, science, industry, and farmer ingenuity. They may legislate to regulate problems that do not exist or are no longer serious.

Of concern is possible future shortages of key inputs such as fossil fuels and phosphate. Years of low oil prices have invited complacency and low investment in new energy capacity. That makes the world vulnerable to an oil shock traumatic to agriculture and other sectors of the economy.

Turning to fiscal policy, the nation has not yet learned to live within its means. Federal fiscal policy is unsustainable and will lead to economic shocks such as flight from the dollar. Income transfers to agriculture will be one casualty of efforts to restore fiscal responsibility. Unstable interest and exchange rates are other consequences of unsound fiscal policy.

Although farmers will learn to live without commodity programs in the twenty-first century, they will face substantial federal environmental regulation. The nation's fiscal problems will mean that the "stick"of federal regulations rather than the "carrot" of government "green" payments will be the principal delivery system.

The forces of science, technology, the market, and public policy are unrelenting in moving agriculture towards commercialization. Only

360,000 farms will account for four-fifths of farm output by year 2010. The operators and families on those farms will account for only 0.5 percent of the nation's population, hence they will not win any political battles by pure voting strength alone. Neither will commercial agriculture triumph in the political arena by appeals to farm fundamentalism, romantic-nostalgic images of the family farm, and an idyllic agrarian heritage. Commercial agriculture will succeed politically only as part of a larger coalition with groups with similar goals and objectives.

The agricultural establishment comprised of commercial agriculture, farm organizations, agribusinesses, agricultural committees of Congress, land grant colleges of agriculture, and the U.S. Department of Agriculture will be divided and weakened. Colleges of agriculture will be diluted by budget and enrollment problems and will be merged with schools of natural resources, life sciences, and environmental sciences. Most students will be from urban backgrounds. The U.S. Department of Agriculture will be merged along similar lines. Institutions serving agriculture will struggle to serve a wider set of issues and clientele in an era of budget stringency. The result will sometimes be strained relations with traditional clientele.

Production agriculture will not give up on land-grant colleges despite some differences. Private industry alone cannot supply the basic and adaptive research essential for success of agriculture in a global economy where competitors adopt the latest in science and technology. Productivity gains are essential to maintain real farm income and output as commodity programs fade. Objective science is ever more essential in an age of continuing dialogue with counterculture and populist elements.

Agriculture will feel besieged by animal rightists, radical environmentalists, small farm advocates, neo-Luddites, and autarkists. Farm organizations will spend lots of time and money on the defensive.

Cooperative and private credit agencies serving agriculture also will serve other sectors to reduce risks and realize economies of scale and scope. They will maintain strong desks for agriculture. Small farm operators will feel ignored, not because lenders don't like them but because small loans take too much time and effort to be profitable.

Agriculture committees of Congress will handle a smaller share of policy for agriculture. The most important business of agriculture will come through natural resource, environmental, and appropriations committees.

This paper is not intended to be a counsel of gloom, however. My basic message is that *American agriculture will be more productive, more profitable, more financially robust, and more environmentally sound in the 21st century than ever before.* Erosion rates will be down from previous decades. Food will be more abundant, safer, and lower in real cost than ever before. Consumers will live longer, healthier, more active lives.

This is not to say that family farms will not face economic challenges. Some of the most notable are briefly summarized in conclusion:

- *Instability.* I have often said that farmers can adjust to consistently high prices and incomes or consistently low prices and incomes but they have difficulty adjusting to persistently unstable conditions. Instability from weather, exports, and policy decisions of governments will continue to plague agriculture. Government measures to alleviate burdens will diminish; farmers will learn to make better use of private risk-management devices such as insurance, forward markets, and buffer stocks.

- *Asset control.* Economic farming units typically will require $2 million or more of assets. Because the family farm must be refinanced each generation, it is burdened in generating net worth to form an economic unit. Strategies such as aid from parents and off-farm work help, but difficulties will intensify of competing with publicly-held corporations not facing life cycle problems.

- *Cash flow.* Adequate size commercial farms will earn favorable economic returns on average but cash-flow problems will be severe and related to asset control. Cash-flow problems arise because of inflation, price and income volatility, the life cycle of the family farm, ever rising capital required for an economic farming unit, and high saving rates required to service debt. To cope with cash flow and asset control problems, farm operators will rely more on leasing, part-ownership, and contracting. They will make more use of off-farm equity and debt capital.

- *Management.* Really poor managers have left America's farms, but remaining farmers vary widely in managerial capabilities. The sophisticated business and technical skills required of tomorrow's successful commercial family farm operator are awesome. The farmer will manage in a context of

increasing risk and outside control by environmental agencies, banks, input supply firms, and government. Operators chosen mainly because they are the sons or daughters of operators may not possess the temperament (e.g., risk tolerance), skill, and education required of a successful operator. However, I anticipate no shortage of commercial farm operators who account for most farm output (see Tweeten and Zulauf). Only about 5,000 new commercial operators will be needed per year. Ranks can be filled from sons and daughters of commercial farm operators, from noncommercial farm operators, and from nonfarm-raised operators. Land-grant colleges will continue to provide sound training, with internships in many cases for prospective operators without farming experience. Also nontraditional management styles such as vertical integration can create efficiencies by "franchising" management to contracting producers and growers.

Corporate industrial inroads into agriculture have been surprisingly modest, mainly because the family farm is efficient. The family farm is remarkably resilient. Despite challenges, I expect it to be the dominant type of farm in America to year 2000 and beyond.

TWENTY-FIRST CENTURY AGRICULTURE: BESIEGED, PRODUCTIVE, AND PROFITABLE

by
Luther Tweeten*

This paper outlines major forces for change in agriculture, and traces some of their implications. Forces of technology, internationalization, environmentalism, and public policy and institutions are highlighted. *Zeitgeist* is seldom mentioned in papers of this type, but is addressed herein because "the spirit of the times" underlies public opinion that determines public policy for agriculture and other sectors.

Agriculture of the next decade and beyond will be technologically advanced, internationally competitive, environmentally sound, market oriented, demand driven, financially innovative, and managerially intensive. Yet, agriculture will often be under siege from environmental, animal rights, and other activists. Public policy will be less about income transfers to producers and more about food security for consumers. The industry will prevail and be a stellar performer despite distractions because it will make sound decisions in response to market incentives and because it is backed by the finest human resources, infrastructure, and science in the world.

Technology

The pace of technological change remains awesome. Conservation tillage and disease control technologies continue to raise agricultural productivity while freeing labor and resulting in fewer, larger farms. I also discuss three emerging technologies that eventually will deliver on their hype: bio-engineering, cybernetics, and information systems.

- *Conservation Tillage.* When I was on the farm in the 1950s, virtually all corn was tilled with a moldboard plow leaving on the average 2 percent surface residue. In 1991, only 15 percent of the corn acreage was tilled by moldboard plow in the Cornbelt (U.S. Department of Agriculture, February 1992, pp. 20-23). Percentages tilled by the moldboard plow were (a) 3 percent for soybeans in the Southeast (b) 7 percent for spring wheat, (c) 18 percent of the soybeans in the Cornbelt, and (d) 21 percent of the cotton. Other acreage was tilled by equipment that left far more residue and hence conserved soil and moisture.

Conservation tillage, the Conservation Reserve, Conservation Compliance, and other measures have halved soil erosion since the 1950s (see Tweeten and Forster). Output-increasing technologies such as improved varieties and synthetic chemicals also saved soils by doubling productivity since 1950, thereby reducing the number of acres that need to be cropped. Thus soil erosion could be four times greater today without the soil-saving and output-increasing technological gains since 1950.

Conservation tillage also is reducing labor requirements in agriculture. For example data indicate that no-till corn farming takes 0.2 hours per acre to "till" corn in the Cornbelt compared to 0.8 hours per acre with the conventional moldboard plow. According to an Ohio survey (Batte *et al.*), no-till reduces *total* operator family and hired labor time to produce and harvest corn by 30 percent. The implication that a family farm can handle 30 percent more acres with conservation tillage than with conventional tillage also means continued pressure for fewer, bigger family farms. Reduced tillage also requires less power and machinery per acre.

- *Disease Control and Economies of Size.* Ability to realize economies of size in vertically

---

*Anderson Professor of Agricultural Marketing, Policy, and Trade, The Ohio State University, Columbus, Ohio. Comments of Lynn Dellenbarger and Jerry Sharples are greatly appreciated.

integrated "factory" farms producing livestock and poultry is possible only by using modern methods of disease control. Disease control on such farms extends beyond subtherapeutic antibiotics to a range of disease prevention and control techniques under the supervision of a veterinarian. The technology for disease control in large units will continue to improve, furthering vertical integration along with separation of farms that produce feed from farms that feed poultry and livestock.

No longer is the farm that produces the feed also the low-cost feeder, because mechanization and other cost savings in large operations offset costs of shipping feed. The result has been to move much poultry and hog production to the Southeast, beef production to the Great Plains, and dairy production to California. In the process, farm labor continues to be displaced. An Ohio contracting firm plans to use clusters of four standardized 700-hog finishing buildings per operator. Each will average 2.5 generations per year for a total of 7,000 hogs marketed. The entire 4-unit operation will require only a half-time male or female operator. That operator will be properly trained by the contractor, but will not require previous experience feeding hogs!

I now turn to the promise of bio-engineering, cybernetics, and the information superhighway. The impacts of these technologies lie further in the future than those addressed above.

- *Bio-engineering*. Bio-engineering remains a technology of promise. Bovine somatotropin is the flagship. At best, it will expand national milk production per cow a cumulative 10 percent, or about 1 percent per year for ten years (Tweeten 1991). This compares with growth in milk output per cow of 5 percent per year in the 1950s. Thus a new bST-equivalent technology would be required every two years to achieve the growth rate in productivity per cow achieved in the 1950s. That will not happen, and, fortunately, other technologies are promising. For example, artificial insemination, a more conventional technology, will have double the impact of bST on output per dairy cow in the next decade.

Pork growth hormone (porcine somatotropin) is expected to produce hogs with a third less fat and 15 percent more lean, using one-fourth less feed grain per pound of gain (Avery, p. 8). That will modestly expand demand for pork while freeing some acres currently producing hog feed for other crops. An important contribution of biotechnology will be to tailor plants and animals to specific demands as discussed below.

- *Cybernetics and Specificity*. Other technologies may get the headlines but the major source of productivity gains will be hundreds of small new and improved technologies used in better ways than ever before. Cybernetics, the control of systems, will enhance the productivity of fertilizers, pesticides, computers, and other "conventional" technologies. The Global Positioning System is an exciting technology for use with cybernetic computers for tailoring fertilizers and pesticides to the needs of each area within a farm field. The result will be reduced pesticide and fertilizer use and/or higher yields. Computer software operating off universal product codes and other information systems will facilitate similar specificity in consumption, allowing consumer products to be tailored to niche markets.

The promise of specificity is illustrated from one page of a recent issue of *Progressive Farmer* magazine. It announced that DuPont is producing high-oil corn under contract with American farmers for export to Mexico. It also announced that Pioneer Hi-Bred International signed an agreement to provide Kraft Foods with a specialty cooking oil from the soybean variety on license from Iowa State University. Bio-engineering will allow much greater detail in developing varieties for specific markets. Cybernetics will integrate control of these production and marketing systems.

- *Information Superhighway*. The "information revolution" in agriculture has been less spectacular than many anticipated. The human mind is incapable of processing the massive flow of data from information footpaths, let alone superhighways. To be sure, digital technology and fiber optics are changing the way we exchange information. But the promise of the information superhighway will remain just that without better information filters and more investment in human capital of farm operators and agribusiness managers who must process the information.

Summary Comments

- Technological change will continue apace, but will be the product of a large number of small changes rather than quantum leaps in technologies comparable to the tractor or hybrid varieties.
- I project U.S. multifactor productivity gains

to be rising 1.5 percent per year for aggregate output of crops and livestock in year 2000 (Tweeten, 1994).[1] That compares to productivity growth averaging 2.5 percent annually in the 1950s. The major problem of producers in the next decade and beyond will be instability in yields in the face of less reserve grain stocks to buffer food supplies and prices.

- In a recent study (Tweeten 1994), I examined American yield trends since 1950. Yields are plateauing or are straight-line trends for corn, wheat, cotton, soybeans, and livestock. Yields of American wheat, soybeans, and cotton are rising less rapidly than foreign yields. For most crops and livestock, the percentage rate of increase in U.S. yields is projected to be halved between 1950 and year 2000.
- Data indicate a sharp rise in the variability of yields and overall productivity since 1980. Some blame the rising variability on global warming, others on the inherent sensitivity to weather of new varieties, and others on "normal" random weather cycles that may or may not be repeated. At any rate, a continuation of high variation in yields in the face of declining buffer stock grain reserves and deficiency payments could make the next decade an unprecedented period of instability in farm prices, production, and income.
- Complex technological and information systems will place a premium on good management. Shortages of top management capabilities will require increasing separation of labor from management. Operators who are alert to opportunities, adequately capitalized, well trained, and business-oriented will do well.
- Economies of size will be prominent. Forces of technology will push us toward even larger, fewer farms. Large farms have been quicker to adopt conservation tillage, computers, and forward contracting – technology and management essential for survival of commercial operations. A major new economy of large farms will be the ability to interpret and apply environmental and other regulations imposed by government.

Larger farms able to afford specialized labor and management will be in a better position than smaller farms to profit from detailed information systems. Thus the information superhighway will be like other technologies – speeding trends toward commercialization and fewer, larger farms.

Internationalization

More open world markets, essential for American agriculture to prosper, can be pursued along multilateral, regional, and unilateral lines. While the Uruguay Round is encouraging, I predict that the major gains over the next decade will come from regionalism and unilateralism.

That the Uruguay Round for the first time integrates agriculture into the General Agreement on Tariffs and Trade (GATT) reassures us that multilateralism is not dead. The Uruguay Round converts to tariffs many nontariff trade barriers plaguing world trade for decades. And a promised World Trade Organization to replace the GATT may bring discipline to enforce trading rules.

That only one-tenth of potential economic gains from world free trade will be achieved by the Uruguay Round (if accepted by all participants) also warns that multilateralism is barely alive. Hopes are dim that a new round of GATT negotiations will deliver major trade liberalization in the next decade.

The post Cold War promise of a new world order has delivered mostly new world disorder. Centripetal and centrifugal forces continually interact to evolve new world orders of nation states and trade regions (Tweeten, August 1993, p. 810). The chief centripetal forces pulling nations together for geographical cooperation are technology and economics. Technology creates economies of size and specialization that raise the opportunity cost of isolation. That is, without access to international markets many large-scale production and marketing systems cannot deliver on their promise of lower costs to consumers.

Tribalism, manifest in its varied forms such as clannishness and nationalism, is the principal centrifugal force fragmenting the globe. Despite the cultural homogenizing influences of mass media and global pop culture, tribalism is prominent everywhere, even in such unlikely places as Quebec and Scotland. Free trade areas make the world safe for tribalism because small-state subcultures can keep their sovereignty while realizing economies of size through free regional trade.

For the next decade, the principal promise for freer trade rests with regionalism and unilateralism rather than with multilateralism. The North American Free Trade Agreement (NAFTA) was negotiated in 30 months, and achieved greater trade

liberalization in North America than the Uruguay Round achieved in seven years. As a measure of potential success, U.S. farm exports to Canada have been rising 7 percent annually since the Canadian-U.S. Trade Agreement was signed in 1989. Agricultural and total trade among nations within NAFTA and within the European Union (EU) has been growing much more rapidly than world trade.

Nine trade regions are in various stages of being formed or implemented in the Western Hemisphere alone. By year 2000, the 12 nations of the EU will add several members of the former European Free Trade Association (EFTA). Soon after year 2000, the EU may add several members of the former East Bloc. These free trade regions will not necessarily become more protectionist. For example, EFTA countries will need to lower trade barriers to join the EU.

Unilateralism, a nation or trade region acting alone on trade policy, also is not dead. Trade models show that national income gains are greater with unilateral than with multilateral liberalization (see Tweeten, May 1992). It is notable that the EU, U.S. and many other countries reduced protection unilaterally – before completion of the Uruguay Round. That contradicts the elementary negotiating principle of not making concessions before a final agreement. Countries acted prematurely because unilateral liberalization made sense; they couldn't afford continued protectionism. Trade economists fear damage to foreign relations when the U.S. acts alone to break down foreign trade barriers under Super 301, but they recognize that it will sometimes work to liberalize trade.

Thus liberalization will proceed through regionalism and unilateralism in the next decade. That is mostly good news for agriculture. However, it is important to recognize that, although economic gains to consumers and the nation are greater with unilateral agricultural trade liberalization, farmers fare better with multilateral liberalization because it raises world market prices.

Other important trade developments are the rise of Asia, less-developed countries, and high-value products as outlets for American agricultural exports. The rise of Asia and the relative decline of Europe in U.S. agricultural trade have shifted the farm trade center of gravity within the country away from Columbus, Ohio towards Lincoln, Nebraska. It means that the eastern Cornbelt no longer enjoys a price premium because it is closer to export markets. At the same time the western Cornbelt has an export alternative and is no longer wedded to feeding livestock to get the most out of its grain and soybean production. The result will be to encourage greater livestock production in the East and more grain exports from the western Cornbelt. Other factors such as urbanization discussed later work against the East, however.

The rise of Asia in world trade and development creates mixed influences on agriculture. High man-land ratios give Asia a comparative advantage in manufacturing rather than agriculture. If Asians can overcome their attachment to self-sufficiency and will let markets work, they will become major food importers. The 200 million people of Japan, Taiwan, and Korea constitute 30 percent of our farm export market, importing $13 billion or $65 dollars of our farm products per capita. China and India with about 2 billion people also have high man-land ratios but import only $600 million or 30 cents of our farm products per capita. Raising China's and India's per capita imports from us to $27 (40 percent the level of Japan, Taiwan, and Korea) would double U.S. farm exports.

That outcome, if promising, is remote indeed. I anticipate that U.S. agricultural export gains will average 2.5 to 5.0 percent annually by the year 2000. Advances from NAFTA, the Uruguay Round, and from the emerging markets of Asia will be partly offset by trade reversal as many Eastern European and former Soviet Union countries become net food exporters (see Sharples).

Environment and Natural Resources

I now turn to what is happening in selected public goods markets, especially for the environment and natural resources.

- Low input sustainable agriculture (LISA) is losing fashion but reasonable people will continue to search for an environmentally sound agriculture (ESA). Because labor, management, and technology requirements can be large in sustainable systems, the term "low input" in LISA is a misnomer. Furthermore the word "sustainable" (derived from a strategy to maintain fish yields in perpetuity) is not ambitious enough for agriculture. Agricultural output must be more than sustainable; it must *grow* to meet increasing demand for food. While organic farming will fill niche markets

providing a price premium and will be favored by some producers and consumers, organic versus nonorganic agriculture is not the seminal issue. The issue for the next decade is how to supply food demands (and ensure profits to farmers) at minimum resource cost while meeting reasonable environmental targets.

Society is unaware of how far the farm and agribusiness communities have progressed in addressing that issue. Conservation tillage and pest control technologies available today enable good farm managers to meet reasonable environmental standards without loss of output or profit (Hopkins). The nation's successes in reducing soil erosion, and in restraining synthetic chemical contamination of water and food have been documented (Tweeten 1992; Tweeten and Forster). Ground water, surface water, and food contamination from chemicals are manageable problems not needing draconian intrusions from government regulations. The danger is that a public unaware of the advances and unsympathetic to agriculture will press for unjustified intrusions into farm operators decisions and property rights.

As a society becomes more affluent, its demand for environment moves from soil erosion control to protection of ground and surface waters to odor control. Loss of romantic-nostalgic images of grandad's family farm will decrease nonfarmers' acceptance of farming practices deemed objectionable. Urbanites and gentrified rural residents will be less and less tolerant of odors from livestock production, especially from "factory"farms. Some implications of the above trends follow:

- Location of economic activity will be based increasingly on public attitudes rather than more narrow comparative advantage. Livestock production is moving to the Great Plains and South not because that is where feed costs are lowest but because that is where the public will tolerate the odors and the economic size operations required for efficient livestock production. External and internal economies of size compensate for being far from feed sources and markets.
- Farm policy increasingly will be made outside the agricultural establishment. That is, Congressional committees concerned with the environment and appropriations rather than agriculture will initiate major legislation that will have an impact on the farming economy.
- Commodity programs will no longer be relied upon for delivery of environmental protection because programs reach only half the nation's cropland. The public will insist that all highly erodible cropland come under conservation compliance provisions. Federal appropriations for agriculture will shift from deficiency payments to green payments for environmental compliance. That shift will not provide sufficient funds, however. Given budget stringency, the only way to accomplish universal compliance is with mandates rather than with voluntary, paid compliance.
- Farmers will be treated more like nonfarmers. Farmers will be issued regulations and expected to comply or penalties will be imposed. Although green payments will be used to compensate for some "taking"of property, the "stick" will increasingly replace the "carrot" to induce participation in environmental programs.
- The most serious long-term natural resource problems of agriculture, declining petroleum and phosphate reserves, will belatedly get some attention. In the last great "world"boom, the 1950s and early 1960s, one-tenth of the global population was on a high growth and industrialization path. Half of the world's population is now on a high growth path, and oil demands are accelerating accordingly. Low oil prices have encouraged complacency in energy capacity investments. The World Energy Council estimates oil in the Earth's crust will last 60 years at *today's* consumption rate (Power to the People). But annual oil use could increase from 60 billion barrels today to 90 billion barrels by year 2010. Much of the increased use will come in Latin America and Asia. Phosphate rock reserves adequate to serve 85 years at current consumption trends will also increase in price to ration supplies and encourage substitutes and new technology (CAST). Shocks to energy and phosphate supplies will reverberate through global agriculture.
- Subtherapeutic use of antibiotics and waste disposal restrictions could limit factory type livestock systems. However, waste disposal, now a major problem for large operations, could turn into an asset because phosphate deposits can be recovered from lagoons economically feasible on large farms but not on small farms.
- A significant share of the funding of farm organizations will go to education programs and litigation designed to protect agriculture from capricious and irresponsible environmental laws and

regulations. Agricultural groups will press for economic impact statements and benefit-cost analysis to accompany imposition of environmental regulations and for protection of property from "taking" without compensation. Protection of property rights will be a continuing struggle.

Federal and State Public Policies and Institutions

The topic of this section is broad and space is limited, hence I will confine my discussion to federal macroeconomic policy and land-grant colleges.

Macroeconomic Policy

Federal macroeconomic policy provided major shocks to agriculture in the 1970s and 1980s. Since 1980, the Federal Reserve has managed the money supply competently to restrain inflation. At issue is how long restraint can last in the face of political pressure to ease the money supply as a (misguided) means to restrain interest rates and repay the nation's debt with cheap dollars.

Progress seems apparent towards a balanced budget. Gains are misleading, however, because budget deficits are unusually low in this expansionary phase of the business cycle but are expected to rise in the late 1990s. In addition, major new social programs are incubating that Congress and the President may not be willing to pay for.

Another problem is that federal deficit statistics fail to reveal the fiscal burdens facing us in the future. *Changes* in the gross national *debt* are better indicators than are federal *deficits* of how much the nation is living beyond its means. (Changes in gross federal debt include off-budget items and also money borrowed from the federal trust funds that will need to be repaid out of taxes serving the current account.) Increments in federal debt are about one-fourth greater than deficits and nearly $300 billion, so debt is increasing about 7 percent per year. This rate exceeds the growth rate of GDP, hence is not sustainable.

The growing federal debt causes short- and long-term problems. An economy growing 3 percent or more per year requires nearly all private (individual and corporate) savings just to serve private investment; the federal deficit needs financing from foreigners. The short-term problem is a falling dollar and rising interest rate due to foreigners' unwillingness to finance our deficit. The long-term crunch will set in when the current baby boom generation begins to retire in about 2010. The public will need to repay the billions that it has borrowed from the social security account at a time when the number of retirees is large relative to workers. Either taxes will have to be sharply increased or expenditures cut. With interest on the debt far exceeding the budget deficit by that time, the public will not feel it is getting its money's worth from taxes paid. Our children could energize a major tax revolt as the bill incurred by us for living beyond our means comes due.

Income transfer entitlements to the middle class are likely to be significantly cut, including the income support features of farm commodity programs. The 1995 farm bill will continue the phase out of income transfers for commercial agriculture that began with the 1985 farm bill. After a decade commodity programs as we know them will be gone, including acreage reduction programs, deficiency payments, export subsidies, and government stock accumulation. Some green payments and risk insurance assistance will be retained, however.

Land-Grant Colleges

Land-grant agriculture colleges integrating research, extension, and resident instruction have been the model and envy of the world. They are an integral part of the success of American agriculture in raising productivity while protecting the environment. As does much of agriculture, such colleges now feel they are under siege. Land-grant colleges, it is said, have lost their way. Budgets have been slashed and personnel cut. The epitome of the change in direction is succinctly captured by a recent Minnesota press release stating that the extension service will change its emphasis in rural counties from "cooking and cows" to "drug abuse among teens and child neglect." This symbolizes both the sorry state of society today and the competition it poses to the traditional role of land-grant colleges – raising agricultural productivity.

Our clientele is widening. What would seem to be a blessing becomes something else when rising expectations are contrasted with falling budgets to serve those expectations. Land-grant colleges are expected to serve not only our traditional clientele, production agriculture, but also hobby farms, organic farms, community and rural development,

environmental science, food science, agribusiness, and international marketing, trade, and development. In trying to be all things to all people, we are accused of serving none well. We have been accused of neglecting our past political base, production agriculture, without building a political or financial support base among new clientele. We risk losing our traditional base of support before we have built a new base.

Zeitgeist

My treatment of concrete issues has only touched on the spirit of the times that permeates the way we think about matters affecting agriculture and society. Of this great sweep of ideas in recent times, the most important is what we variously refer to as alternative or counterculture agriculture. Counterculture agriculture views agriculture as too important to be left to agriculturalists.

Counterculture groups are not monolithic, and many have little background in agriculture. They include activists especially concerned with issues of gender and race. They include deep environmentalists concerned with species preservation, biodiversity, global warming, and the ozone layer as well as traditional environmental issues. They include animal rightists who would accord rights of humans to animals, and neo-Luddites who would avoid new technologies, especially biotechnologies. Autarkists oppose trade, and look to regional and national self-sufficiency. Radical small-farm advocates oppose large corporate/industrial/factory/contract farming and favor intrusive government measures to maintain family farms.

Thus mainstream agriculture will be contending with more than crop and livestock pestilence in future years. A substantial portion of many farm organization's budgets will be devoted to education, public relations, and court costs.

This is in no way denies the legitimacy of many issues on the alternative agriculture agenda. As indicated in the previous section, a more diversified land-grant college will incorporate issues of food, the environment, and alternative uses for agricultural products (e.g., ethanol) that will sometimes bring conflict among agricultural interests. When objective science and education on critical issues bring acrimony within the agricultural establishment, relationships between colleges of agriculture and traditional production agriculture will be strained, but they will not be severed. The two will continue to need each other.

Implications for Agriculture

I now review implications of technology, internationalization, resources/environment, institutions, and *zeitgeist* for agriculture. Technology, internationalization, resources, and institutions interact in determining supply/demand balances and farm structure.

Supply/Demand Balance

Aggregate domestic plus export demand for farm output is expected to grow 1.4 to 2.1 percent per year by year 2000 (Tweeten 1994). Domestic demand is projected to grow by a rather predictable 1.0 percent per year, hence the range of projections comes from the highly volatile export demand.

The lower aggregate demand expansion (1.4 percent) assumes the 1970-1990 trend rate of increase in farm exports which averaged 10 percent in the 1970s but falls to a mathematically projected 2.5 percent in year 2000. Some of my colleagues contend exports will grow 5 percent per year by 2000 due to expansion in emerging markets of Asia and the strong showing from NAFTA and the Uruguay Round. If exports rise 5 percent in year 2000, aggregate demand will increase 2.1 percent.

With total demand expected to grow 1.4 to 2.1 percent per year by year 2000 and productivity at a slightly faster rate (see earlier text and footnote 1), the parity ratio (ratio of prices received to prices paid by farmers) will fall modestly. But the parity ratio adjusted for productivity growth will be nearly double its 1910-14 average by year 2000!

The long-term economic position of commercial agriculture is easy to predict. Except for transitory weather and cyclical shocks, commercial agriculture has remained near economic equilibrium for decades and will continue to do so. Within the range of demand and supply increases (1.4 to 2.1 percent per year) expected to year 2000, reasonably well managed, adequate size farms will earn returns on resources comparable to what those resources can earn elsewhere. Competent operators on farms with sales of $250,000 per year will earn about a 10

percent return on their equity. Larger and better managed operations will earn more. Small part-time farms will earn essentially the median national income from off-farm employment less their farm losses which they will accept to enjoy the amenities of rural living and tax advantages. Small full-time and poorly managed farms will lose money and some will be in poverty, but they will need to be helped by poverty programs—commodity programs aren't of much help.

These supply/demand trends will support land earning and land prices keeping up with inflation. Like farm commodity prices and incomes, however, farm real estate prices will vary cyclically and from year to year.

Structural Change

Forces discussed in this report will continue major changes in the structure of agriculture. Recent evidence reveals that the trend toward fewer, larger farms continues unabated. The relentless trend is towards a more commercial, scientific, and technologically advanced agriculture.

Figure 1 projects numbers of all farms declining 1.1 percent per year to year 2010. Commercial farm (annual sales over $100,000) numbers increase slowly but noncommercial farm numbers are projected to decline 1.9 percent per year.

The share of national output accounted for by farms depends on their size as well as numbers. Commercial farms are expected to grow 2.6 percent annually in sales per farm (Figure 2). By year 2010, only 360,000 commercial farms will account for 82 percent of farm gross income. The gain in sales share by farms with over $100,000 in sales from 71 percent of output in 1980 to 82 percent in 2010 is the result mainly of falling numbers of noncommercial farms and not because of an explosion in the average size of commercial farms.

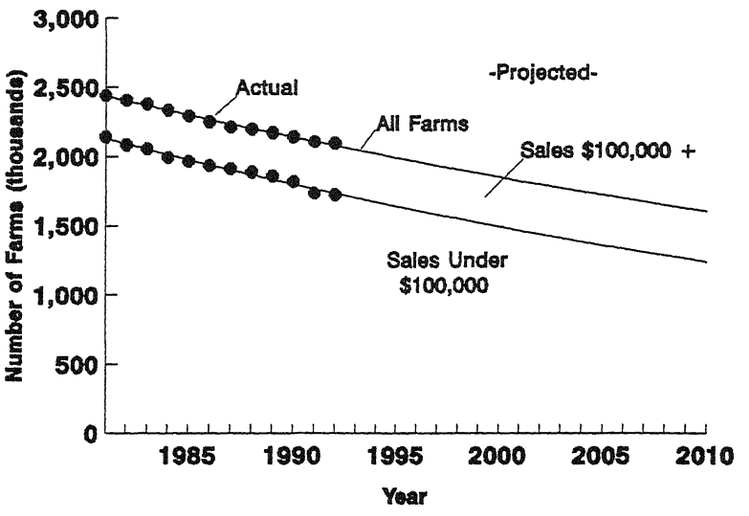
Figures 1 and 2 are from U.S. Department of Agriculture data (Economic Research Service) and are not revised for 1992 census data. Recently released agricultural census data for selected states support trends in Figures 1 and 2 but indicate commercialization may be progressing more rapidly than anticipated (Annex Table 1). Tentative conclusions based on selected available 1992 census of agriculture results are as follows:

- The trend toward fewer farms remains very strong, especially in the Midwest where the six states in my sample lost farm numbers by amounts ranging from 7.56 percent in Missouri to 12.59 percent in Illinois from 1987 to 1992. Only Iowa had a smaller percentage loss in farms in the 1987-92 period than the 1982-87 period, and its loss was a sizable 8.21 percent in 5 years.
- Numbers of farms by size in *acres* increased for small farms (1-49 acres), markedly increased for large farms (1,000 + acres), and fell for mid-size farms.
- Measured by number of farms by *value of sales* size, large farms again fared very well while numbers of small and medium size farms declined. Thus size measured by acres gives more support for the "disappearing middle" hypothesis than does size measured by sales. The issue needs sorting out as more data become available.
- The proportion of operators annually working 200 day or more off the farm decreased in all of my 12 sample states. Proportions fell from the 1982-87 period to the 1987-92 period. Accelerating commercialization of farming and concomitant rapid drop in the number of part-time small farms may account for less off-farm work.
- Several of the 12 sample states report a rising proportion of farmers over time who state that farming is their principal occupation. This finding too is consistent with accelerating commercialization.

In addition to accelerating commercialization, other structural characteristics will change by year 2000 based on census and other data:

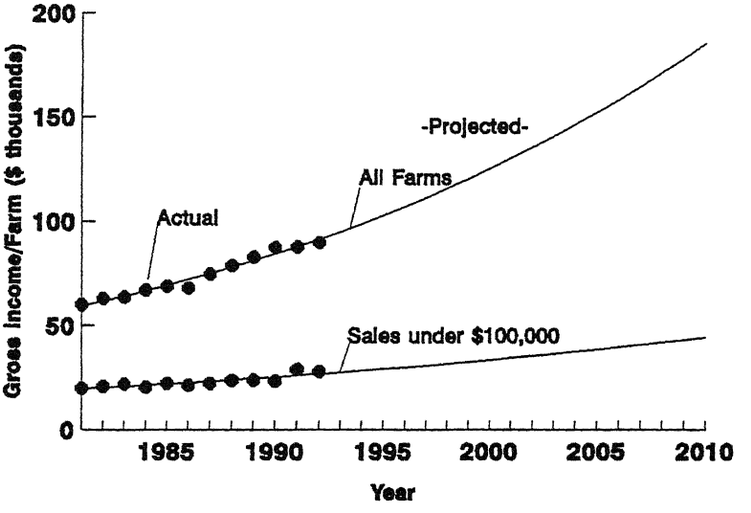
- Most farm operators will be full owners but most land will be farmed by part owners. Small farm operators will tend to be full owners while commercial farmers will lease land to realize economies of size.
- Larger-than-family corporations will account for less than 1 percent of all farms by year 2000, but may account for 5 percent of all acres.
- Vertical coordination is of two types – production/marketing contracts and vertical integration – and will account for a rising share of production. Production/marketing contracts such as milk and vegetable marketing orders increased from 15.1 percent of production in 1960 to 22.9 percent in 1980 and could reach 30 percent in year 2000. Vertical integration characterized by operation or control of two or more levels of the input supply, farm production, and product marketing chain expanded from 3.9 percent in 1960 to 7.4 percent of production in 1980 and could reach 16 percent

Figure 1. Number of Farms from 1981 to 1992 and Projected to 2010



Source: US Dept. of Agriculture

Figure 2. Gross Farm Income Per Farm from 1982 to 1992 and Projected to 2010



Source: US Dept. of Agriculture

by year 2000. Hogs provide the most dramatic recent example of expanding vertical integration. Vertical integration will be prominent in all major livestock and poultry operations in year 2000, and also is prominent in some crops such as sugarcane.

Institutional Responses to Stop Structural Changes in Agriculture

The continuing commercialization of agriculture so apparent in this report is considered by many to be a threat to traditional family farming. In response, at least 12 states restrict corporate or partnership farming in some way, although all states allow corporate *family* farms (Tweeten 1993). A number of states attempt to exclude large agribusiness and other firms from direct farm operations and in some cases from owning agricultural land.

After reviewing state laws and regulations restricting corporate or industrial type farming, I concluded that state laws as currently structured contain sufficient exemptions and exclusions to allow industrial-type farming operations if profits warrant. Statistical data indicate no difference in corporate activity in states with and without laws limiting widely-held corporations.

Tough state laws forbidding widely-held corporations or partnerships from engaging in farm production and contracting would create an anti-business climate discouraging not only farm but nonfarm business activity generating highly desired investment, jobs, income, and economic growth. Any state passing such laws would find itself bypassed, and see dynamic businesses such as integrated livestock operations going to other states. Thus any truly effective law forbidding industrial farming would need to be national in scope. That is now not politically feasible. Some state governments will continue to pass ineffective legislation but the federal government will not act.

Populist organizations, environmentalists, and local residents will continue to oppose large integrated livestock and poultry operations. Populists oppose competition to family farms while local residents fear loss of property values and quality of life due to odors and traffic.

Much of the opposition is misplaced for several reasons. Rejection of large, integrated feeding operations often means driving out (or failing to attract) the very packing plants that would provide markets essential to preserve traditional family farm feeders. Other areas or states will welcome large operations with the employment, income, and output they generate. States rejecting contract farming will see economic activity go elsewhere.

At any rate, the more urban-industrial states that have been traditional sources of poultry and livestock production will see their shares erode. The Eastern Cornbelt will be especially disadvantaged by its urban-industrial character, high wages, and dense rural and urban populations unfriendly to large farming operations.

Institutional Response: Land Grant Colleges

The appropriate means to address counterculture agriculture is with science, education, and dialogue. That science and education must be as objective as possible and the dialogue a two-way learning process. Land-grant colleges are in a unique position to facilitate that process.

Commodity program support parameters have been cut in half in real terms since the 1981 farm bill. The paradox is that real net farm income has continued to climb since 1985 when the 1981 farm bill expired. That happened because of increasing exports and farm productivity. Production agriculture will continue to support public science and education in part because productivity advances will be even more important for international competitiveness as commodity income supports are phased out.

Problems of land-grant colleges are easier to state than to solve. But let me try to forecast how we might address the problem. First, it is necessary to recognize that land-grant colleges have three major audiences. The first is the professional audience, calling principally for disciplinary, basic science using resources allocated largely by judgments of individual scientists. The scientist in turn is responding to signals from the profession and to peer groups on promotion, tenure, and research grant committees. This meets the demand for disciplinary public goods – a proper niche for a public agency to fill in a market economy. But researching and writing mainly to impress other professionals will not win many friends in political and agricultural circles.

The second major audience is state and local problems primarily of production agriculture. That research is problem-solving, applied, and multidisciplinary. Deans of agriculture, directors of agriculture experiment stations, directors of the

cooperative extension services, and department heads play a role in allocating resources in this category. But administrators increasingly are unable to prevail against professional pressures to do disciplinary research in an age of rising faculty autonomy.

The third major area is demand for applied research on national problems. The loudest voices nowadays on national issues come from alternative agriculture and counterculture groups. They call for research on the environment, small farms, organic agriculture, appropriate technology, and issues of race, gender, drugs, and crime.

One means of allocation of research resources on such national issues is *competitive grants*, but funding has been modest relative to cost of preparing, reviewing, refereeing, and administering grants. Grant agency funds are often for purposes peripheral to meeting the needs of production agriculture for low cost, safe, abundant food supplies. Also, *special grants* have originated from Congress, but allocations have been troubled by political favoritism.

In my judgment, a serious shortcoming of the system (in addition to the general problem of too few funds to serve our many clientele and issues) is neglect of basic and applied production agriculture problems that are not addressed by the private sector at the state and local level. Reforms are needed to restore proper balance. One is to base promotion of scientists less on professional journal articles and more on applied professional contributions to problems of food and agriculture.

Secondly, grant procedures can and will be changed. Competitive grant funding drives out formula funded research on problems of production agriculture. Formula funded research pays salaries. But researchers are encouraged to seek outside grants for operating funds to do research. The grant agency funds may be modest but they are the "tail" that wags the state formula-fund "dog." It may be argued that administrators can overcome the lure of grant funding by allocating funds to faculty positions (salaries) in fields of pressing needs. Unfortunately, that approach doesn't suffice in this era of faculty autonomy.

I predict that administrators in land-grant colleges will use more of their "formula" funds to provide their own "competitive" grants to get faculty to work on pressing issues of state agriculture and to offset the tendency for other funding agencies to drive out research on local and state issues. Funds must be available to reach beyond the narrow problems of production agriculture, of course, and must address environmental and social issues. More state and local funding will follow as land grant colleges address perceived needs of the state.

A serious concern is declining real federal financial support of land-grant college research and extension (Tweeten, 1994). Without more federal sharing of efforts, states will view research too narrowly and will underfund efforts with large spillover of benefits to other states. The nation has had a strong tradition of federal assistance to decentralized research and extension efforts allocated by researchers and by administrators around the nation most knowledgeable of real problems and means to alleviate them. Continuation of current trends will compromise that successful tradition.

States unable to publicly fund essential weed specialists, for example, or new biotechnology experiments will look to industry for financial support. Such cooperation in land-grant colleges can lead to conflicts of interest. Critics successful in cutting public funds for such colleges because of alleged conflicts of interest could intensify reliance on industry support. Despite drawbacks, cooperation with industry will make land-grant scientists more productive and will continue the close working relationship between scientists and clientele in the land-grant tradition. Critics will need to become part of that interaction and dialogue.

Finally, land-grant colleges will specialize to serve regional clientele. Colleges in regions with similar problems will divide specialties to avoid duplication and get more science and education out of limited funds.

Endnote

1. Results differ depending on methods of projection. Based on the USDA's newly revised index of multifactor productivity, productivity could be growing at an annual trend rate of 2.2 percent in year 2000 under optimistic technology forecasts.

References

Avery, Dennis. June 1994. "The Greatest Opportunity in Farming History." Paper presented to Great Plains Symposium held at Fargo, ND. Indianapolis, IN: Hudson Institute.

Batte, Marvin, Lynn Forster, and Kevin Bacon. 1994. "Economic Performance of Alternative Tillage Systems on Ohio Farms." Columbus: Department of Agricultural Economics, The Ohio State University.

CAST. 1988. *Long-Term Viability of U.S. Agriculture*. Report No. 114. Ames, IA: Council for Agriculture Science and Technology.

Hopkins, J. W. 1993. "A firm-level model of agricultural effluents in the face of environmental regulation and free trade." Unpublished M.S. thesis. Columbus: The Ohio State University.

Power to the People. June 18-24, 1994. *The Environment*. 331:1-18.

Robinson, Bob. June 1994. "Global Food Production Prospects in the Next Century." AO-208. *Agricultural Outlook*. Washington, DC: ERS, USDA, pp. 28-31.

Sharples, Jerry. Second Quarter 1994. "World Events Shaping Future U.S. Agricultural Trade." *Choices*, pp. 4-9.

Tweeten, Luther. 1994. "Are We Investing Enough in Agricultural Research and Extension?" Paper presented to Council for Agricultural Research, Extension, and Teaching (CARET), Washington, DC, June 18, 1994. Columbus: Department of Agricultural Economics and Rural Sociology, The Ohio State University.

_____. 1991. "The Costs and Benefits of bGH Will be Distributed Fairly." *Journal of Agricultural and Environmental Ethics*, 4:108-120.

_____. May 1992. "The European Community and Trade Liberalization: An American Perspective." Pp. 171-175 in Symposium II Proceeding of International Agribusiness Management Association, Oxford England, UK.

_____. 1992. "The Economics of an Environmentally Sound Agriculture (ESA)." Pp. 39-83 in Ray Goldberg, ed. *Research in Domestic and International Agribusiness Management*, Vol. 10. Greenwich, CT: JAI Press.

_____. August 1993. "Trade regionalism: Promise and problems." *American Journal of Agricultural Economics*. 75:811-816.

_____. 1993. "Types of Farming Units, Competitiveness, and Farm Succession in the United States." Proceedings of seminar *Families versus Firms in Farming*, Tsukuba, Japan.

Tweeten, Luther and Carl Zulauf. Second Quarter 1994. "Is Farm Succession a Problem?" *Choices*, pp.33-35.

Tweeten, Luther and Lynn Forster. Fourth Quarter 1993. "Looking Forward to Choices for the 21st Century." *Choices*, pp. 26-31.

U.S. Department of Agriculture. February 1992. *Agricultural Resources: Inputs Situation and Outlook Report*. AR-25. Washington, DC: Economic Research Service, USDA.

Annex Table 1.
Percentage Changes for Selected Farm Characteristics, 1982 to 1987 and 1987 to 1992.

State	Farms		Share of Farms by Size (Acres)						Share of Farms by Value of Sales ($)						Oper. working 200 days or > off farm		Oper.-Farming Principal Occ. (Share)	
			1-49		50-999		1000 +		Less than 10,000		10,000-99,999		100,000 +					
	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92	% ch. 82-87	% ch. 87-92
Florida	0.56	-3.70	3.84	2.38	-4.25	-3.69	-7.35	1.98	0.85	-3.89	-2.77	3.48	2.04	10.60	-1.20	-13.15	0.79	8.67
Maryland	-8.69	-11.77	0.05	0.64	-0.79	-1.07	21.46	13.66	8.55	-7.77	-14.12	3.24	2.37	18.77	-6.31	-17.10	-1.23	0.37
Maine	-10.48	-7.86	6.56	11.61	-2.12	-4.21	10.09	21.30	-1.33	-3.28	-2.10	2.41	10.53	8.66	-8.67	-17.58	-1.29	0.48
Virginia	-13.61	-5.75	-2.44	2.78	0.58	-1.74	17.71	9.55	-0.38	-7.72	-0.84	11.30	6.38	25.00	-11.42	-8.18	-0.93	0.72
Iowa	-8.87	-8.21	2.80	0.43	-1.68	-1.84	31.60	38.46	12.72	-6.18	-3.57	-9.79	-1.75	25.60	2.73	-1.39	-4.00	-3.20
Illinois	-9.85	-12.59	-1.49	4.20	-1.60	-4.06	36.34	36.60	-0.16	-4.93	2.70	-10.33	-5.25	29.18	-6.83	-7.48	-0.62	-4.12
Kansas	-6.46	-7.73	2.04	-5.36	-3.36	-1.53	10.30	8.43	8.82	-8.55	-4.76	-3.17	-4.36	34.84	1.74	-8.86	-3.69	0.03
Missouri	-5.64	-7.56	9.91	-0.93	-3.24	-1.01	16.12	20.58	-2.59	-2.27	3.06	-3.17	3.25	28.96	-0.64	-7.64	-2.75	-0.78
Ohio	-8.81	-10.81	-.42	2.32	-0.58	-2.03	32.21	34.11	0.00	-6.84	-1.63	1.24	6.45	26.99	-7.52	-10.44	0.50	-1.95
Wisconsin	-8.60	-9.55	-3.56	5.97	0.41	-1.66	25.76	23.31	1.79	3.37	-7.85	-12.56	21.24	24.63	-7.05	-2.50	0.73	-4.29
Idaho	-2.31	-8.36	2.87	2.71	-3.14	-2.13	6.59	1.64	6.99	-2.65	-6.10	-6.57	-1.89	19.83	1.75	-4.51	-2.44	-1.89
Oregon	-6.08	-0.38	-2.02	4.12	0.45	-5.69	12.25	0.31	-5.71	-2.15	2.00	1.16	38.90	9.00	-10.39	-4.40	5.22	0.04

Source: U.S. Bureau of the Census, 1992 Census of Agriculture.